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Multimedia, Multipollutant Field Study to Establish Levels of Toxic Contaminants in Air Soil, Sediment, Water and Agricultural Products from a Model Municipal Waste Combustor

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MULTIMEDIA, MULTIPOLLUTANT FIELD STUDY TO ESTABLISH LEVELS OF TOXIC CONTAMINANTS IN AIR, SOIL, SEDIMENT, WATER AND AGRICULTURAL PRODUCTS FROM A MODEL MUNICIPAL WASTE COMBUSTOR

L. Fradkin[1], T. Hartlage[2], R. Watts[2],
R. Harless[2], J.F. Walling[2], D. Cleverly[2]
U.S. Environmental Protection Agency
[1]Cincinnati, OH 45268 and [2]Research
Triangle Park, NC 27711

B.J. Fitzgerald, G.A. Heil and H.T. Garabedian
Agency of Environmental Conservation
State of Vermont
Waterbury, VT 05676

P.M. McGinnis
Syracuse Research Corporation
Cincinnati, OH 45206

EPA Project Officer
Larry Fradkin

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16. ABSTRACT In the past, assessments have been directed only at the public health risks posed by stack and fugitive emissions of pollutants from municipal waste combustors (MWCs) by direct inhalation exposure. Recently, the U.S. EPA has developed methodologies to extend risk assessment to a consideration of indirect exposure pathways in addition to the direct inhalation pathway. A better understanding of the multipollutant and multiple exposure pathways of emissions from waste combustors is needed in order to improve the overall assessment of the risks to humans and the environment. This study will provide a preliminary determination of the overall risks associated with MWCs. As part of this overall approach, a field evaluation of a MWC was selected in Rutland, Vermont. During a one-year period, a four station ambient air monitoring network for pollutants will be operated by the State of Vermont. The purpose of the monitoring is to ensure that the pollution controls and regulatory requirements imposed on the facility are sufficient to prevent adverse impacts on human health or the environment. Ambient air samples will be analyzed for specific organic and inorganic components and also for mutagenic components which may be associated with MWC. In addition, grab samples of agricultural products, soils, sediments and surface waters surronding the facility will be collected and analyzed for similar toxic contaminants. This study will provide a framework for future multipollutant, multimedia field assessments of other MWCs.

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In the past, assessments have been directed only at the public health risks posed by stack and fugitive emissions of pollutants from municipal waste combustors (MWCs) by direct inhalation exposure. Recently, the U.S. EPA has developed methodologies to extend risk assessment to a consideration of indirect exposure pathways in addition to the direct inhalation pathway. A better undertanding of the multipollutant and multiple exposure pathways of emissions from waste combustors is needed in order to improve the overall assessment of the risks to humans and the environment. This study will provide a preliminary determination of the overall risks associated with MWCs.

As part of this overall approach, a field evaluation of a MWC was selected in Rutland, Vermont. During a one-year period, a four station ambient air monitoring network for pollutants will be operated by the State of Vermont. The purpose of the monitoring is to ensure that the pollution controls and regulatory requirements imposed on the facility are sufficient to prevent adverse impacts on human health or the environment. Ambient air samples will be analyzed for specific organic and inorganic components and also for mutagenic components which may be associated with MWC. In addition, grab samples of agricultural products, soils, sediments and surface waters surrounding the facility will be collected and analyzed for similar toxic contaminants. This study will provide a framework for future multipollutant, multimedia field assessments of other MWCs.

Introduction

In the past, most analyses of human health risks associated with atmospheric emissions from combustion sources have focused only on exposures occurring by direct inhalation. Recent studies, however, have linked elevated levels of pollutants in soils, lake sediments and cow's milk to atmospheric transport and deposition of pollutants from combustion sources[1-4]. These studies suggest that deposition of atmospherically-emitted pollutants could result in additional indirect routes of exposure for humans as well as other organisms. Recently, the U.S. Environmental Protection Agency (EPA) developed methodologies to extend risk assessment to a consideration of indirect exposure pathways in addition to the direct inhalation pathway. A better understanding of the multipollutant and multiple exposure pathways of emissions from waste combustors is needed in order to improve the overall assessments of the risks to humans and the environment.

The U.S. EPA entered into a cooperative agreement with the State of Vermont to conduct a field evaluation of a municipal waste combustor (MWC) in Rutland, Vermont. The purpose of this study is to provide a framework for future multipollutant, multimedia field assessments of MWCs.

The Rutland Resource Recovery Facility

The Rutland Resource Recovery Facility (RRRF) is located in Rutland, Vermont, a city with a population of ~18,000. Rutland is situated in west-central Vermont in a mountain valley, with the ridges to the east and west rising over 1000 feet above the valley floor. The facility in western Rutland is located on rather flat terrain at an elevation of 554 ft. mean sea level (m.s.l.). Hills rising to over 1000 ft. m.s.l. are present to the immediate north-northwest and south-southwest. Elevations over 2000 ft. m.s.l. are found 7 km to the east.

The RRRF, manufactured by Vicon Resource Recovery Systems (Butler N.J.), consists of two mass-fired incinerators, each with a refractory lined furnace and a separate waste heat boiler (modular burners)[5]. Emissions from the two units are vented to separate flues with the same 50m high stack. The pollution control devices are a four-field electrostatic precipitator followed by a condensing heat exchanger and a wet scrubber. Each of the two incinerators at the facility will be limited to an input rate of 120 tons of refuse/day (total of 240 t.p.d.), and the entire facility will not combust more than 80,000 tons/year of municipal solid waste. The steam produced in the waste heat boilers will be used to generate electricity.

A review of the RRRF conducted under the State Air Pollution Control regulation evaluated the potential emissions of seventeen contaminants. In accordance with Vermont Air Pollution Control Department (VAPCD) Regulations, a permit was issued on September 11, 1986.

Study Approach

In order to accomplish the objective of this project, levels of selected toxic pollutants are being measured in the ambient air, soil, water, sediment and agricultural products during operation of the Rutland

RRF. This project is a site-specific and not a process-specific study. Therefore, the inorganics and organics may also originate from other sources in the area. The VAPCD has identified several pollutants to be monitored in ambient air during this project:

- Arsenic
- Beryllium
- Cadmium
- Chromium
- Lead
- Mercury
- Nickel
- Benzo(a)pyrene
- Chlorodibenzodioxins
- Chlorodibenzofurans
- Polychlorinated biphenyls

Additionally, a mutagenicity bioassay of the extractable organic fraction of the collected ambient air samples will be conducted.

Pollutants identified for quantification in soils, water, sediments and agricultural products are:

- Arsenic
- Beryllium
- Cadmium
- Chlorodibenzodioxins (except water)
- Chlorodibenzofurans (except water)
- Chromium
- Lead
- Mercury
- Nickel
- Silver
- Polychlorinated biphenyls (except water)

Dispersion Modeling and Sample Site Selection

Air dispersion modeling analysis of predicted air emissions from the MWC in Rutland, VT, was conducted to recommend the placement of ambient air monitors to measure maximum downwind ground level ambient air impacts of the incinerator emissions. These dispersion models considered source characteristics, terrain, meteorological data and receptor location. Both the UNAMAP 6 version of the Industrial Source Complex Long Term (ISCLT) Model[6] and the LONGZ Model[7] were used to predict average annual air concentrations of pollutants in the vicinity of the MWC.

Five years of meteorological data (1970-1974) from the National Weather Service Station in Albany, NY, were used because the most recent available meteorological data for several years in an area similar to Rutland was required. Modeling was repeated using data recorded at a site near the State Courthouse in Rutland and cloud cover observations from Burlington, VT, during the 1-year period of 1980. The wind patterns were generally very similar to Albany, with Rutland having a higher frequency of wind from southwest through north-northwest. Using the Rutland-Burlington data, results similar to the analysis with the Albany data were found.

Both models were run using polar grid receptors as well as discrete individual receptors. Maximum annual average ground level concentrations were estimated from the source for 16 wind directions beginning with south and spaced every 22.5° along the polar azimuth at distances of 0.2, 0.5, 1.0, 2.0, 5.0, 10, 20, 30, 40, and 50 km from the MWC (for a total of 160 receptors). The discrete receptors were sited at 59 locations to better define the point of maximum concentration and were also placed near sensitive segments of the population, e.g., schools and hospitals. Dispersion modeling showed the areas for maximum impact lie within a 1 km

radius from the MWC stack.

Air Monitoring Sites

Based on the results of the air dispersion modeling, a four-station ambient air network was established for monitoring the selected metals and organics. The stations are located on municipal property with three of the stations close to modeled sites of highest estimated annual average concentration of pollutant emissions or close to areas of topographical importance, and the other station is the existing Vermont State and Local Air Monitoring Station (SLAM) shelter. The sites are (Figure 1):

1. State APCD SLAM Shelter: 1.3 km east in an urban area of Rutland City at the State District Court House.
2. Old Havenworth School on Watkins Avenue, Rutland City: 0.25 km north near the modeled site of estimated maximum impact from the facility and located in a residential neighborhood.
3. Rutland Town Municipal Building: 0.7 km west in the narrow valley formed by Otter Creek. The site is 200 ft to the south of Route 4 behind the Rutland Town Municipal Office Building.
4. Next to River Street Pumping Station, River Street, Rutland City: 0.4 km south-southwest in a topographical depression near the junction of East Creek and Otter Creek.

Two ambient air monitoring stations have been designated as co-located sites for quality assurance purposes[a].

At each monitoring network, several types of sampling equipment are being used. Each monitoring site has two General Metal Works PS-1 samplers, one standard mass flow TSP (Total Suspended Particulate) high volume (Hi-Vol) sampler and one Wedding PM-10 critical flow Hi-Vol sampler. The Hi-Vol samplers, TSP and Wedding Model PM-10, and the Pesticide Sampler Model PS-1 are being employed to monitor the selected metals and organics in the ambient air surrounding the MWC. The metals, arsenic, beryllium, cadmium, chromium, lead, nickel and silver, and B(a)P will be collected by Hi-Vol PM-10 samplers. Separate PS-1 samplers with a glass cartridge filter and polyether-type polyurethane foam (PUF) adsorbent are being used to collect chlorodibenzodioxins/chlorodibenzofurans (CDDs/CDFs), PCBs and a sample for bioassay analysis. The TSP sampler with mass flow controllers and high quality glass fiber filters are used to collect particulate for determination of mutagenic activity. Ambient air samples for mercury are collected, using a low volume vacuum sampler with a mass flow controller, only at the SLAM site due to the need for a controlled environment for the collector.

The sampling frequency for the PS-1 PUF samplers, the TSP high-volume samplers, and the PM-10 high-volume samplers will be for 24 hours once every 12 days for approximately 1 year. This will produce 26 samples/collector (one collector at each site and a co-located collector) or 130 air samples for metal, organic chemicals for mutagenicity testing, B(a)P and PCB analyses.

The number of ambient air sampling days for CDDs/CDFs will be restricted to 21, producing 105 samples from the 5 monitors. The tetra- through octa-CDD and CDF congeners will be the isomers to be determined in

the ambient air. The five other sample days on which the PS-1 sampler is not being used for CDDs/CDFs data collection, ambient air samples will be collected and analyzed for mutagenic activity. Mercury sampling (24-hour) and analysis will be conducted by the VAPCD at the Rutland SLAM site every 12 days for the duration of the study producing 26 samples. All samples are collected on the same day.

Meteorological information, i.e., wind speed, wind direction and temperature are continuously monitored and recorded at two sites, the SLAM station and site #2 at the old Havenvorth School on Watkins Avenue. Climatronics Electronic Weather stations are used to continuously measure each meteorological variable. Additionally, the SLAM site collects rainfall intensity, relative humidity, atmospheric pressure, and solar radiation.

The RRRF began burning municipal waste in November, 1987. Figure 2 presents the relationship between the tons of waste burned and the air concentration of particulates at the four air monitoring stations.

Analytical Procedures

Arsenic and chromium in ambient air are analyzed for total metal by neutron activation (NAA)[9]. Beryllium, cadmium, lead, nickel and silver will be analysed by an Inductively Coupled Plasma Emission Spectrometer (ICP-AES)[10]. PCBs in ambient air will be quantified by gas chromatography with electron capture detection (GC-ECD)[11]. High resolution GC-high resolution MS (HRGC-HRMS) is being used to separate and identify tetra- through octa-CDDs/CDFs[12]. B(a)P will be analyzed by thin-layer chromatography and fluorescence spectrophotometry[13]. A pyrolyzer-dosimeter system has been developed by VAPCD to quantify both elemental mercury vapor and total mercury.

Bioassay Analysis of Ambient Air

Particulate matter on TSP high-volume glass fiber filters and PUF samples from periods not used for CDDs/CDFs ambient air analysis will be used to bioassay the collected materials for mutagenicity. Individual organic chemicals will not be separated and/or identified, but the extractable organic fraction from the filters, most likely a mixture of organic compounds, will be tested for mutagenicity. Mutagenicity testing will be performed by either the standard Ames test plate incorporation assay[14] or the Kado assay[15], a modification of the Ames test. Samples are being grouped for bioassay analysis in order to minimize test variations and allow for accurate comparison of sample sets.

Environmental Media Sampling

Dispersion modeling of emissions from the Rutland RRF indicated that the area of expected maximal deposition will be within a 1 km radius of the facility. Locations for collecting water, sediment, soil and agricultrual product samples are generally within the high-impact area. Grab samples of water and sediment are taken at five locations: the Rutland City Reservoir, Rocky Pond and at three points in the Otter Creek. Milk, carrots, potatoes and forage grass hay samples are being collected

from farms in the area surrounding the RRRF. A systematic grid sampling technique is being used to collect soil samples at the five sites. The metals in water, soil, sediment, milk and agricultural products are being measured by atomic absorption[16-17]. The analysis of PCBs, and PCDDs/PCDFs will be conducted using HRGC/HRMS[18-20].

Conclusion

This study is the first to provide scientific evidence regarding ground level concentrations of air emissions as well as deposition to other environmental media. Protocols are being developed to provide guidance for future field evaluations of municipal waste combustors.

References

1. MEA, Inc., East Helena Source Apportionment Study, "Particulate source apportionment using the chemical mass balance receptor model", Volume 1, Prepared for the Department of Health and Environmental Sciences, State of Montana, (1982).

2. D. L. Swackhamer, "Estimation of the atmospheric and non-atmospheric contributions and losses of polychlorinated biphenyls for Lake Michigan on the basis of sediment records of remote lakes", Environ. Sci. Technol., 20: 879 (1986).

3. J. M. Czuczwa, R. Hites, "Environmental fate of combustion-generated polychlorinated dioxins and furans", Environ. Sci. Technol. 18: 444 (1984).

4. C. Rappe, M. Nygren, G. Lindstrom, H. R. Buser, O. Blaser, C. Wuthrich, "Polychlorinated dibenzofurans and dibenzo-p-dioxins and other chlorinated contaminants in cow milk from various locations in Switzerland", Environ. Sci. Technol. 21: 964 (1987).

5. Air Pollution Control Division, Agency of Natural Resources, State of Vermont, "A review of the potential health effects of dioxin emissions, acid gas emissions, and disposal of dioxin contaminated ash from the Vicon resource recovery facility proposed for Rutland, Vermont, (1985).

6. U.S. EPA, "Industrial source complex (ISC) dispersion model user's guide", (2nd edition), Research Triangle Park, NC, EPA-450/4-86-005a (June, 1986).

7. U.S. EPA, "User's instructions for the SHORTZ and LONGZ computer programs", Philadelphia, PA, PB83-146100 (March, 1982).

8. Air Pollution Control Division, Agency of Natural Resources, State of Vermont, "Rutland resource recovery facility site specific environmental assessment quality assurance plan", (November, 1987).

9. U.S. EPA, "Standard operating procedure for NAA determination of

trace elements in suspended particulate matter collected on glass-fiber filters", Office of Research and Development, Environmental Monitoring Systems Laboratory, Research Triangle Park, NC, SOP-EMD-017 (1984).

10. U.S. EPA, "Standard operating procedure for the ICP-DES determination of trace elements in suspended particulate matter collected on glass-fiber filters", Office of Research and Development, Environmental Monitoring Systems Laboratory, Research Triangle Park, NC, SOP-EMD-002 (1983).

11. U.S. EPA, "Compendium of methods for the determination of toxic organic compounds in ambient air", Office of Research and Development, Environmental Monitoring Systems Laboratory, Research Triangle Park, NC, EPA-600/4-84-041 (1984).

12. R.L. Harless and D. McDaniel, "Method for determination of polychlorinated dibenzo-p-dioxins and dibenzofurans in stack gas emissions and ambient air", presented at: 1988 EPA/APCA Symposium on Measurement of Toxic and Related Air Pollutants (May, 1988).

13. U.S. EPA, "Standard operating procedure for ultrasonic extraction and analysis of residual benzo(a)pyrene from hi-vol filters via thin-layer chromatography", Office of Research and Development, Environmental Monitoring Systems Laboratory, Research Triangle Park, NC, EMSL/RTP-SOP-MDAD-015 (December, 1986).

14. D.M. Maron and B.N. Ames, "Revised methods for the Salmonella mutagenicity test", Mutat. Res., 113:173 (1983).

15. N.Y. Kado, D. Langley and E. Eisenstadt, "A simple modification of the Salmonella liquid-incubation assay. Increased sensitivity for detecting mutagens in human urine", Mutat. Res., 121:25 (1983).

16. U.S. EPA, "Methods for chemical analysis of water and wastes", Office of Research and Development, Environmental Monitoring and Support Laboratory, Cincinnati, OH, EPA-600/4-79-020 (1979).

17. U.S. EPA, "Test methods for evaluating solid waste. Volume IA: Laboratory manual physical/chemical methods", Office of Solid Waste and Emergency Response, Washington, DC, SW-846 (1986).

18. U.S. EPA, "Methods for organic chemical analysis of municipal and industrial watewater", Office of Research and Development, Environmental Monitoring and Support Laboratory, Cincinnati, OH, EPA-600/4-82-057 (1982).

19. U.S. EPA, "Protocol for the analysis of 2,3,7,8-teratachloro-dibenzo-p-dioxin by high-resolution gas chromatography/high-resolution mass spectrometry", Office of Research and Development, Environmental Monitoring Systems Laboratory, Las Vegas, NV, EPA-600/4-86-004 (1986).

20. U.S. EPA, "Analysis for polychlorinated dibenzo-p-dioxins (PCDD) and dibenzofurans (PCDF) in human adipose tissue: method evaluation study", Office of Toxic Substances, Exposure Evaluations Division, Washington, DC, EPA-560/5-86-0 (1986).

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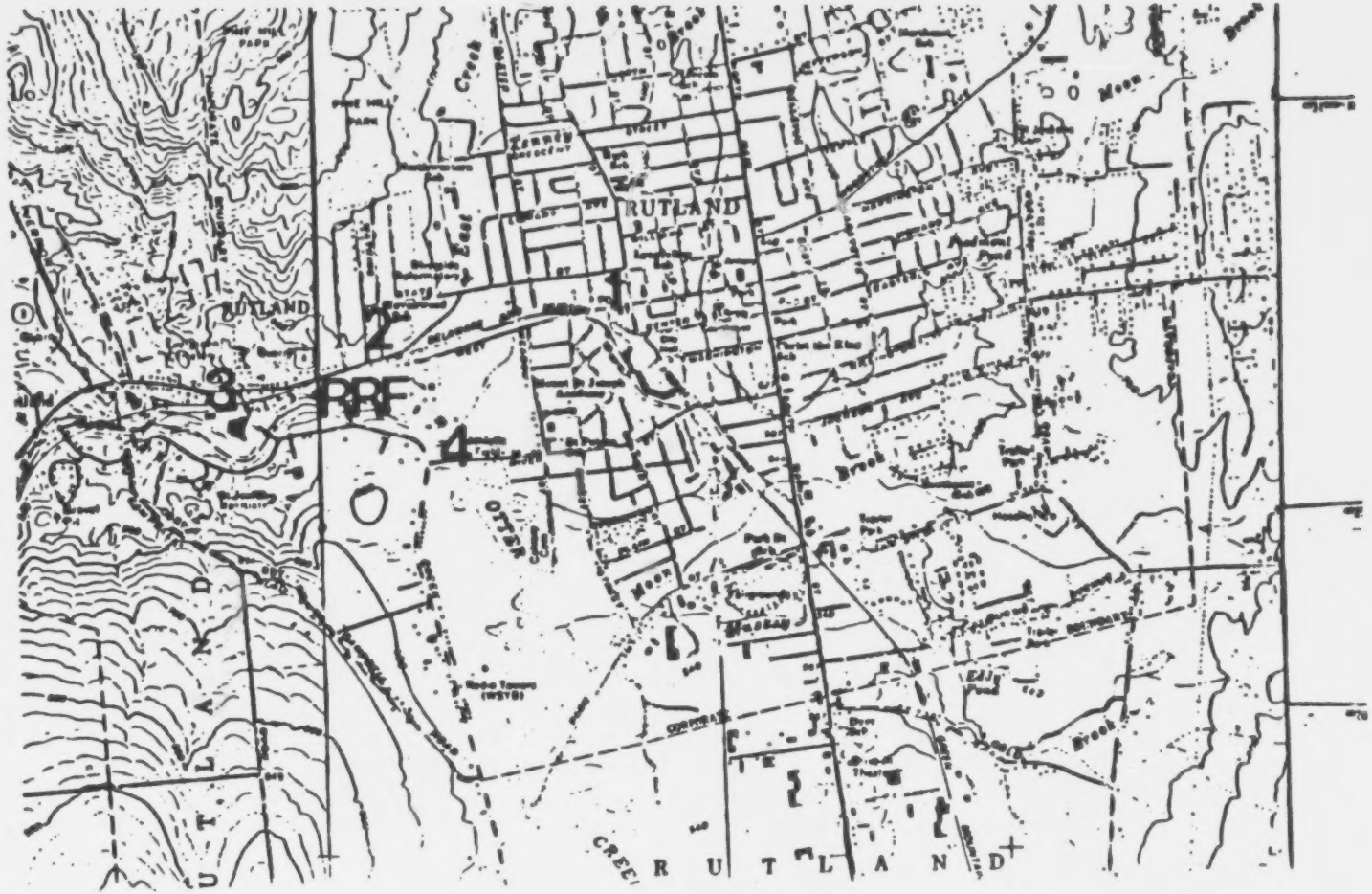

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FIGURE 1. Location of Air Monitoring Stations in Rutland.

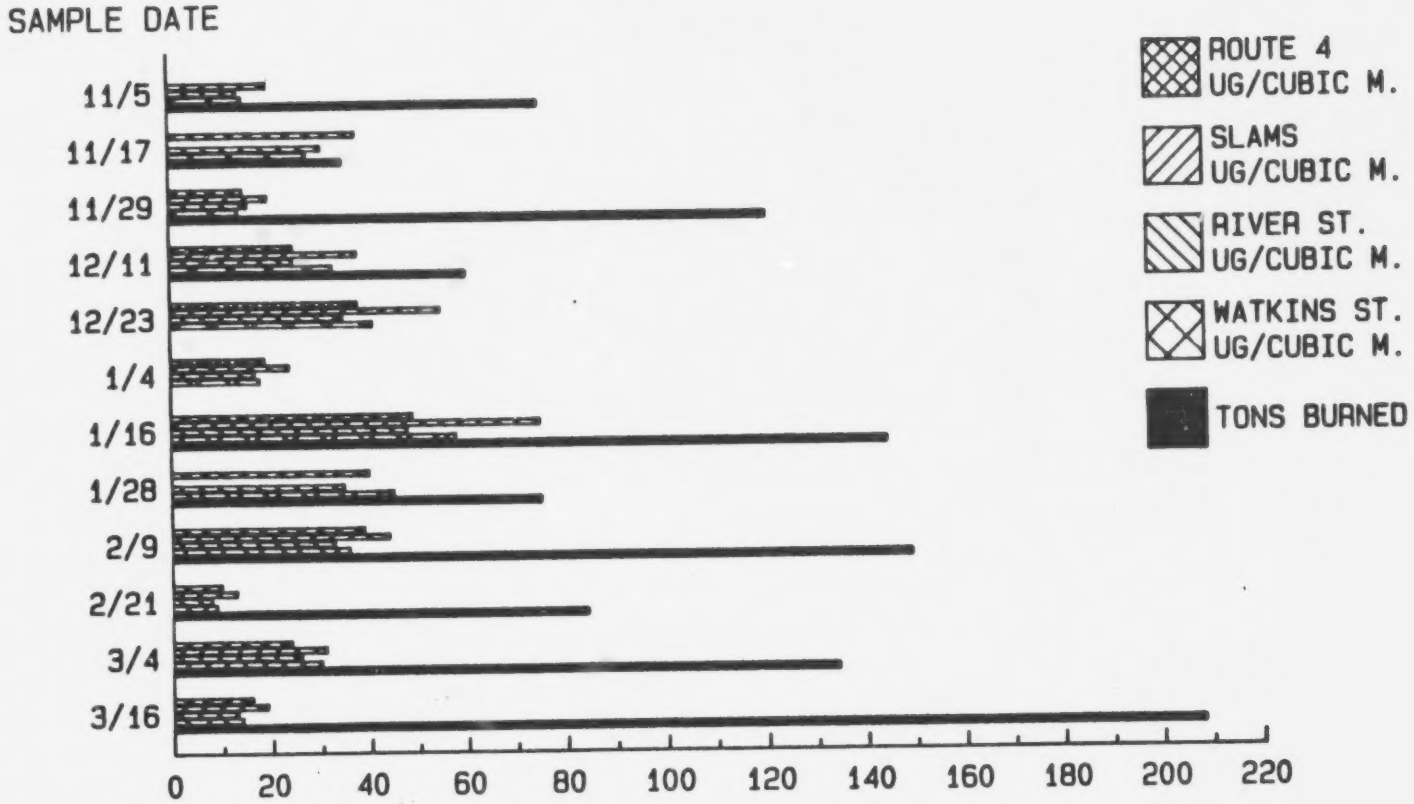

Figure 2. Relationship of Tons of Waste Burned and Particulate Air Concentration at the Four Monitoring Stations.